

CLAIMS

I CLAIM:

1. A loop powered process instrument comprising:
 - 2 a control circuit measuring a process variable and developing a control signal
representing the process variable;
 - 4 an output circuit for connection to a two-wire process loop for controlling current
on the loop in accordance with the control signal; and
 - 6 a power supply circuit connected to the output circuit and the control circuit for
receiving power from the two-wire process loop and supplying power to the control circuit,
8 comprising cascaded charge pump circuits.
2. The loop powered process instrument of claim 1 wherein the charge pump
2 circuits comprise divide-by-two charge pump circuits.
3. The loop powered process instrument of claim 1 wherein the charge pump
2 circuits each have an efficiency of about 95%.

4. The loop powered process instrument of claim 1 wherein the power supply
2 circuit comprises a current source connecting the cascaded charge pump circuits to the output
circuit.

5. The loop powered process instrument of claim 1 wherein the power supply
2 circuit comprises a regulator diode connecting an output of the cascaded charge pump circuits to
the control circuit.

6. The loop powered process instrument of claim 1 wherein the power supply
2 circuit has an input of about 13 volts and 3.5 mA and an output of about 3 volts and about 13
mA.

7. The loop powered process instrument of claim 1 wherein the power supply
2 circuit has an overall efficiency of about 90%.

8. A loop powered process instrument comprising:

2 a control circuit measuring a process variable and developing a control signal
representing the process variable;

4 an output circuit for connection to a two-wire process loop for controlling current
on the loop in accordance with the control signal; and

6 a power supply circuit connected to the output circuit and the control circuit for
receiving power from the two-wire process loop and supplying power to the control circuit,
8 comprising a current source providing a select current to a plurality of cascaded switched
capacitor voltage dividers.

9. The loop powered process instrument of claim 8 wherein the switched
2 capacitor voltage dividers comprise divide-by-two charge pump circuits.

10. The loop powered process instrument of claim 8 wherein the switched
2 capacitor voltage dividers each have an overall efficiency of at least 90%.

11. The loop powered process instrument of claim 8 wherein the switched
2 capacitor voltage dividers each have an efficiency of about 95%.

12. The loop powered process instrument of claim 8 wherein the power supply
2 circuit comprises a regulator diode connecting an output of the cascaded switched capacitor
voltage dividers to the control circuit.

13. The loop powered process instrument of claim 8 wherein the power supply
2 circuit has an input of about 13 volts and 3.5 mA and an output of about 3 volts and about 13
mA.

14. The loop powered process instrument of claim 8 wherein the power supply
2 circuit has an overall efficiency of about 90%.

15. The loop powered process instrument of claim 8 wherein the switched
2 capacitor voltage dividers comprise CMOS switched capacitor voltage converters each having a
pump capacitance and an output capacitance.

16. In a loop powered process instrument including a control circuit
2 measuring a process variable and developing a control signal representing the process variable
and an output circuit for connection to a two-wire process loop for controlling current on the loop
4 in accordance with the control signal, the improvement comprising:
a power supply circuit connected to the output circuit and the control circuit for
6 receiving power from the two-wire process loop and supplying power to the control circuit,
comprising a plurality of cascaded switched capacitor voltage dividers.

17. The loop powered process instrument of claim 16 wherein the
2 improvement comprises two cascaded divide-by-two charge pump circuits each having an
efficiency of about 95%.

18. The loop powered process instrument of claim 16 wherein the switched
2 capacitor voltage dividers comprise CMOS switched capacitor voltage converters each having a
pump capacitance and an output capacitance.

19. The loop powered process instrument of claim 16 wherein the power
2 supply circuit has an input of about 13 volts and 3.5 mA and an output of about 3 volts and about
13 mA.

20. The loop powered process instrument of claim 16 wherein the power
- 2 supply circuit comprises a current source connecting the cascaded switched capacitor voltage
- dividers to the output circuit and a regulator diode connecting an output of the cascaded switched
- 4 capacitor voltage dividers to the control circuit.